Observations on the seasonal abundance and life history of some benthic invertebrates from Great Lake and Arthurs Lake, Tasmania

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ABSTRACT

Seasonal variation in abundance and brief details of the life history of species of chironomids, trichopterans, phreatoicids and oligochaetes from Great Lake and Arthurs Lake, Tasmania are presented. The data are compared with other studies of similar species elsewhere.

The seasonal abundance of the insect species as well as the phreatoicids could be related to the life history of each species. No consistent patterns were detected in the seasonal abundance of the oligochaetes studied.

INTRODUCTION

The only previous studies on the benthic invertebrate fauna of Tasmanian lakes are those of Weatherley and Nicholls (1955), and Timms (1978). These studies did not provide any data on seasonal variations in the fauna or on the life history of any species.

Data on seasonal variation and life history of benthic invertebrates in the lakes of mainland Australia are also sparse. Timms (1973) gives some details for several species in three Victorian lakes whilst Paterson and Walker (1974) studied the life history of a chironomid species in a Victorian saline lake.

One of the primary aims of a study of the benthic faunas of Great Lake and Arthurs Lake (Fulton, 1981) was to investigate seasonal variations in the faunas of those lakes. From the collections made it was possible to draw some conclusions as to the life history of the common species in various taxa. Other details of the faunas are reported elsewhere (Fulton, 1983 a, b).

MATERIALS AND METHODS

Series of samples were collected with an Ekman grab (232 cm^2) from six sites in Great Lake (1975) and six sites in Arthurs Lake (1977-78). Twenty samples were taken at each site with the program commencing at the end of January in each case. Sampling was repeated at the end of every second month over a year in Great Lake and over 14 months in Arthurs Lake. The locations of the sample sites in each lake are given in Fig. 1. Various physical and chemical data relating to these sites are given in Fulton (1981).

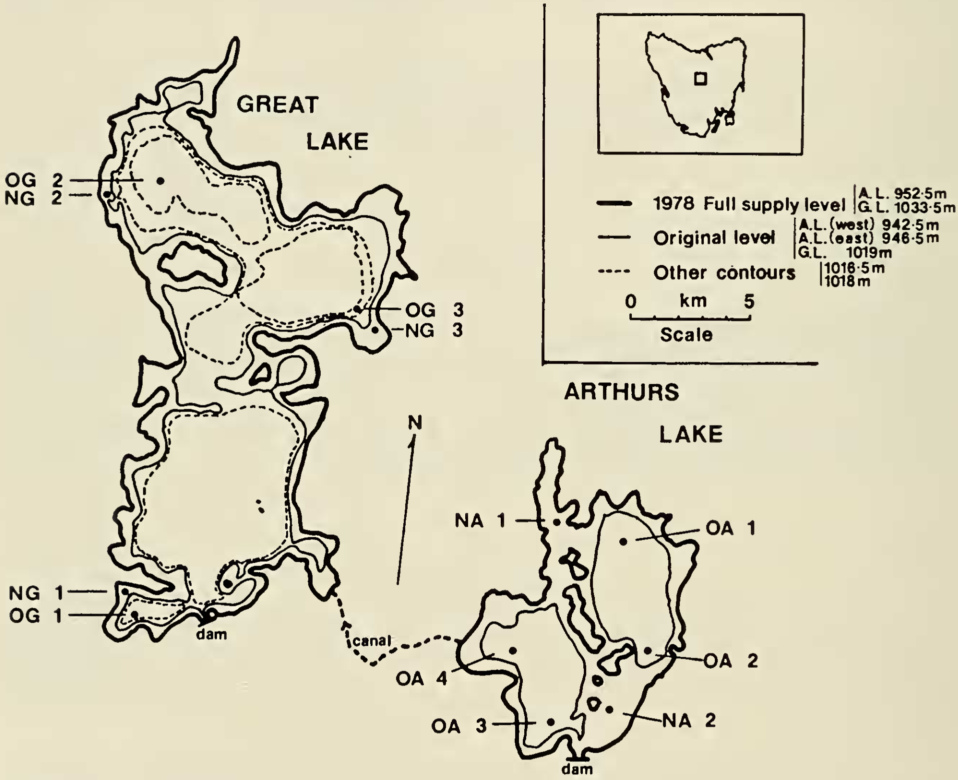

Fig. 1. Sample site locations within Great Lake and Arthurs Lake.

The animals were sorted from the substrate using an elutriation apparatus after that of Lauff *et al.* (1961). The material was passed through a 0.7 mm sieve. This sieve retained the vast majority of animals present in the sample with the exception of early instar stages of aquatic insects.

The basic data from which seasonal variation was observed were the total number of specimens present in each 20 sample series, converted to numbers per

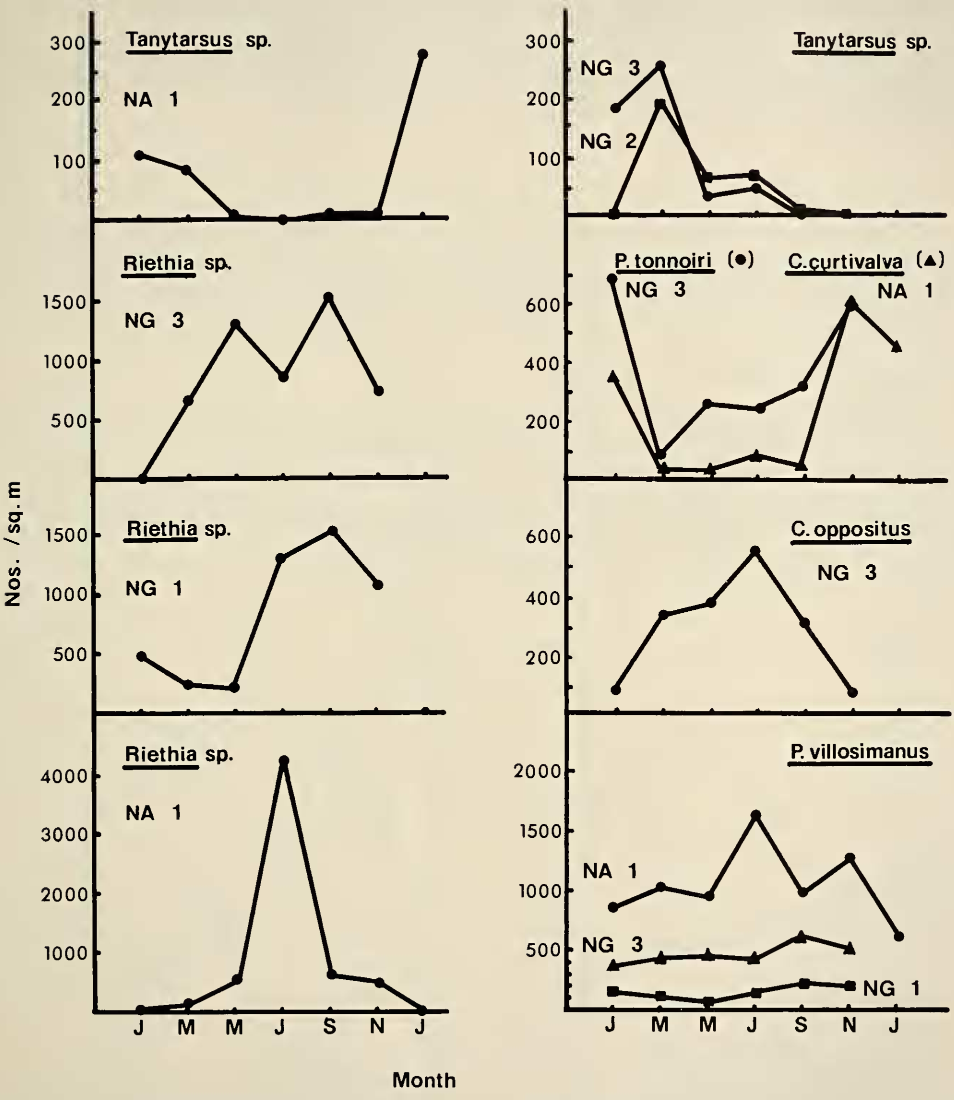

Fig. 2. Seasonal variation in abundance of various chironomid species from Great Lake and Arthurs Lake. Species and collection site are given on each graph.

square metre. Instar stages for chironomids and trichopterans were determined by head capsule width. Phreatoicid size frequency analysis was based on overall body length whilst the trichopteran measurements were of case length.

Specimens of *Riethia* sp., *Tanytarsus* sp. and *Colubotelson* sp., have been deposited in the Tasmanian Museum, Hobart, (registration numbers F1471, F1472, G2725 respectively) should comparisons be required.

RESULTS

The large sample series was designed to give a statistically reliable sample of the population in each case. Therefore, where some inference has been made from the observed variation in seasonal abundance of a species, the assumption has been made that such variation was not a result of errors in the sampling procedure.

Seasonal Variation

Seasonal abundance data for each species in Great Lake and Arthurs Lake were collected but the variations could only be successfully analysed for the common ones. In most cases it was necessary for a species to be common at more than one site so that consistent trends could be detected. It can be seen from Figs. 2-6 that some species show obvious seasonal variations which are consistent between sites, whilst abundance peaks in other species appear unrelated for the various sites.

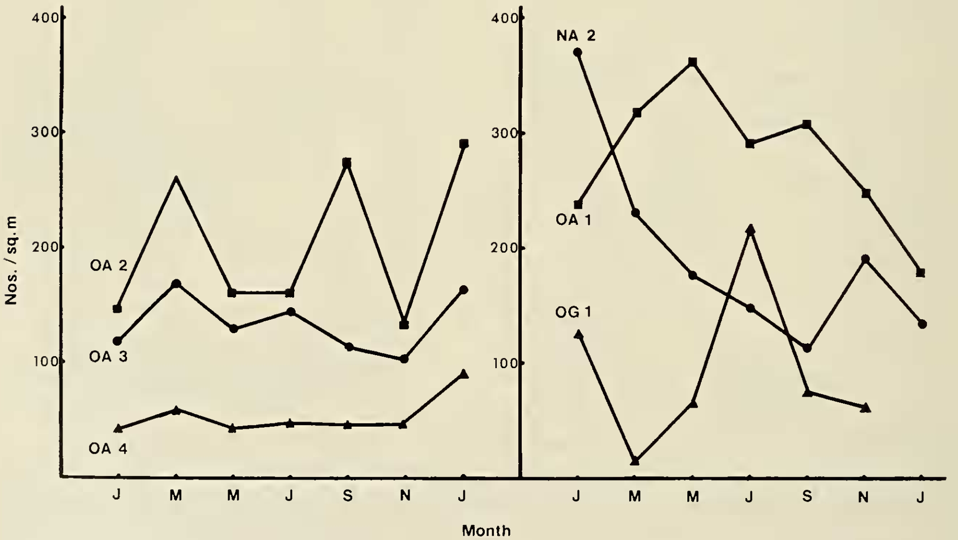

Fig. 3. Seasonal variation in abundance of *Coelopynia pruinosa* in Arthurs Lake and Great Lake.

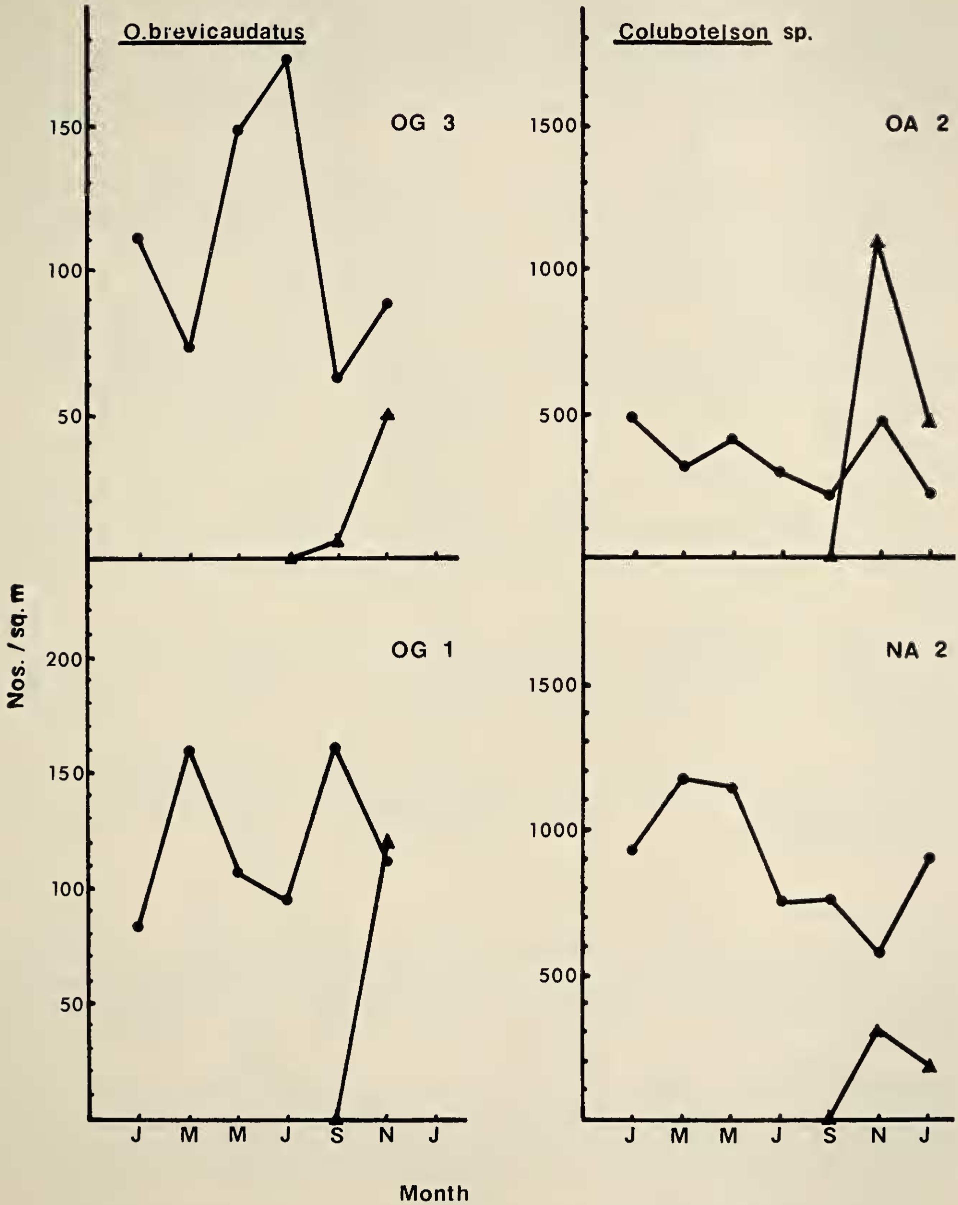

Fig. 4. Seasonal variation in abundance of two phreatoicid species at two sites in Great Lake and Arthurs Lake. New juveniles (▲) are shown separate from the rest of the population (●).

Chironomids: Many of the common chironomids in Great Lake and Arthurs Lake show marked seasonal variation in numbers. Distinct abundance peaks are evident in the species *Chironomus oppositus, Cladopelma curtivalva, Tanytarsus* sp., *Polypedilum tonnoiri* and *Riethia* sp. (Fig. 2). From just five species there are four different peak abundance times with one species (*Riethia* sp.) showing variation between sites.

The peak in numbers of *Riethia* sp. occurs from July through September, whilst *C. oppositus* is most common in late July. *Tanytarsus* sp. was most frequent in March in Great Lake and January in Arthurs Lake. *C. curtivalva* and *P. tonnoiri* both show abundance peaks from November through January.

Another common chironomid species, *Procladius villosimanus,* does not exhibit consistent abundance peaks, (Fig. 2) although there was a peak in late July at one site. The occurrence data for *Coelopynia pruinosa* (Fig. 3) shows considerable variation between sites and seasonal variation patterns are difficult to interpret.

Phreatoicids: Considerable variations were observed in the number of adult *O. brevicaudatus* and *Colubotelson* sp. present at various sites in Great Lake and Arthurs Lake. Nevertheless, there is a consistent influx of juveniles occurring through October and November in both the Arthurs Lake and the Great Lake species (Fig. 4).

Oligochaetes: Of the common oligochaete species studied (*Haplotaxis ornamentus, Telmatodrilus bifidus,* and *Phreodrilus proboscidea*), none appear to show seasonal peaks that are consistent between sites (Fig. 5).

Trichopterans: Only one species, *Atriplectides dubius,* was common at any site (Fig. 6). Numbers of this species show a major peak in late September and a minimum in late May.

Life History

The seasonal variation in abundance of a species largely reflects the life cycle of that species. Some information on life history can be drawn from the seasonal variation data presented, whilst further analysis of the samples has added to this information.

Chironomids: Instar analysis data from chironomid samples were limited by the sorting technique. Numbers of the last two instars only of any species (in some cases only the last one) could be reliably estimated. The smaller early instars were able to pass through the sieve used to separate the animals from the substrate.

The percentages of larvae of various species in each instar stage are given in Tables 1 and 2. For *Riethia* sp., larvae in any stage other than final instar only occurred in January or March samples. From Table 1 and Fig. 2 it appears that

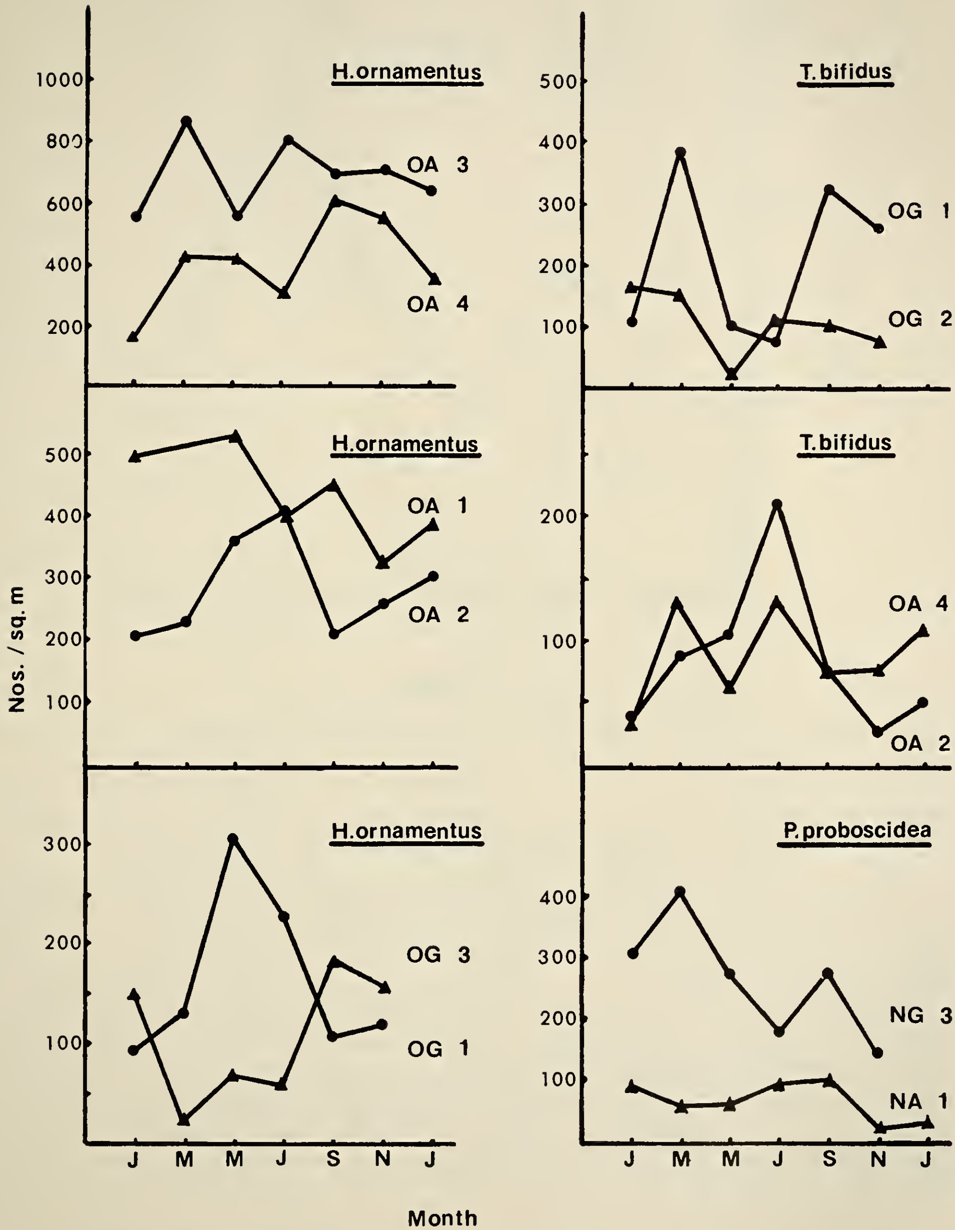

Fig. 5. Seasonal variation in abundance of three oligochaete species at various sites in Great Lake and Arthurs Lake.

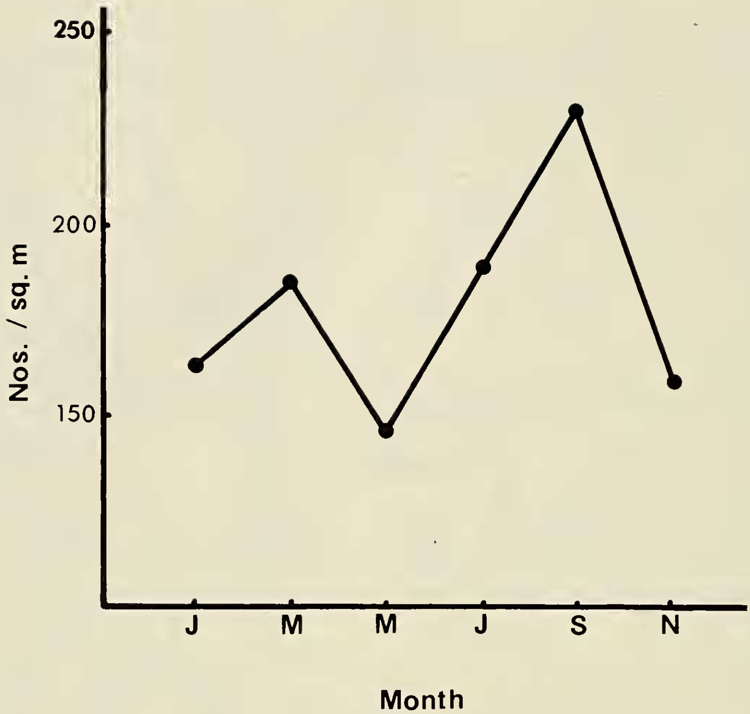

Fig. 6. Seasonal variation in abundance of *Atriplectides dubius* at site NG2.

Riethia sp. emerges in Great Lake and Arthurs Lake from spring to early summer. The new larvae grew to the fourth instar by March of the following year.

Both *Chironomus oppositus* and *Procladius villosimanus* have similar one year life cycles but there is some difference in the rate of growth through to the last instar. *C. oppositus,* from the instar analysis, emerged by mid-spring but the new generation took longer than *P. villosimanus* to reach final instar stage. *P. villosimanus* emerged about the same time as *Riethia* sp. but the young larvae apparently developed more rapidly. Although they only reached the final instar stage about the same time as *Riethia* sp. the third instar larvae were large enough after two months (the time of the following sample) to be retained by the sieve. This meant that no reduction in numbers of *P. villosimanus* was indicated in the abundance data (Fig. 2) even though instar analysis revealed that emergence had taken place (Table 1).

Polypedilum tonnoiri and *Tanytarsus* sp. also exhibit one year life cycles but emergence takes place later than the above three species. *P. tonnoiri* emerged in late summer and the new larvae developed slowly through winter to reach final

TABLE 1. Percentage frequency of each instar of chironomids in samples from Great Lake and Arthurs Lake. (Total numbers are given in parentheses. Samples taken near end of month indicated).

Site	NA 1		NG 3		NA 1		NA 1			NG 3		NG 3	
Species	*Riethia* sp.		*Riethia* sp.		*P. villosimanus*		*C. oppositus*			*P. tonnoiri*		*Tanytarsus* sp.	
Instar	3	4	3	4	3	4	2	3	4	3	4	3	4
	%		%		%		%			%		%	
Jan.	33	67 (9)	—	100 (13)	87	13 (393)	3	94	3 (114)	1	99 (283)	3	97 (82)
Mar.	4	96 (55)	10	90 (413)	1	99 (467)	5	87	8 (122)	84	16 (31)	—	100 (115)
May	—	100 (265)	—	100 (580)	—	100 (440)	—	—	100 (160)	71	29 (103)	—	100 (18)
July	—	100 (1920)	—	100 (380)	2	98 (752)	—	7	93 (15)	69	31 (144)	—	100 (20)
Sept.	—	100 (295)	—	100 (690)	1	99 (448)	—	2	98 (251)	69	31 (141)	—	—
Nov.	—	100 (250)	—	100 (320)	7	93 (585)	—	—	100 (3)	6	94 (255)	—	—
Jan.	50	50 (2)			80	20 (276)	1	95	4 (602)				

TABLE 2. Percentage frequency of each instar of *Coelopynia pruinosa* in samples from Great Lake and Arthurs Lake. (Total numbers are given in parentheses. Samples taken near end of month indicated).

Site	NA 2				OA 1				OG 1		
Instar	2	3	4		2	3	4		3	4	
		%				%				%	
Jan.	—	30	70	(159)	—	41	59	(105)	14	86	(57)
Mar.	—	41	59	(102)	—	48	52	(145)	—	100	(7)
May	1	38	61	(77)	1	50	49	(150)	38	62	(24)
July	—	76	24	(66)	—	42	58	(134)	62	38	(89)
Sept.	—	73	27	(51)	—	53	47	(135)	42	58	(33)
Nov.	15	72	13	(89)	2	51	47	(109)	—	100	(20)
Jan.	—	57	43	(60)	—	6	94	(83)			

instar stage by late spring. *Tanytarsus* sp. emerged in autumn with final instar stage of the next generation being reached by mid-summer of the next year. As this species was quite small, it is likely that only the final instar was reliably sampled. The various instar stages of *Cladopelma curtivalva* were not examined but from the seasonal variation data for this species (Fig. 2) it is likely that it has a life cycle similar to that of *P. tonnoiri.*

The life cycle of the remaining common chironomid species, *Coelopynia pruinosa,* is more difficult to interpret. Data in Table 2 showed that there could be a significant proportion of larvae in each of the third and fourth instar stages at any time of year. The abundance data (Fig. 3) were generally inconsistent between sites although there were usually two peaks in each graph.

It is apparent that the life cycle is not of one years duration (c.f. Table 1) and from Table 2, two generations per year are suggested. A summer emergence is likely, whilst another emergence in May-June is indicated, particularly by the instar analysis of site NA2 and OG1 samples (Table 2).

Phreatoicids: Size frequency of samples of *Onchotelson brevicaudatus* from Great Lake (Fig. 7) and *Colubotelson* sp. (Fig. 8) from Arthurs Lake give some indication of the life history of these two species. The progression of the juvenile class is clearly seen with high mortalities occurring in this group before maturity.

The brood pouch was evident in female *O. brevicaudatus* in Great Lake in the three samples from the end of May until the end of September. Although some large specimens were still present after the influx of the young, it is unlikely that they survived to reproduce a second time. As the juveniles were still sexually undifferentiated after one year it is likely that they are in their second year before they reproduce.

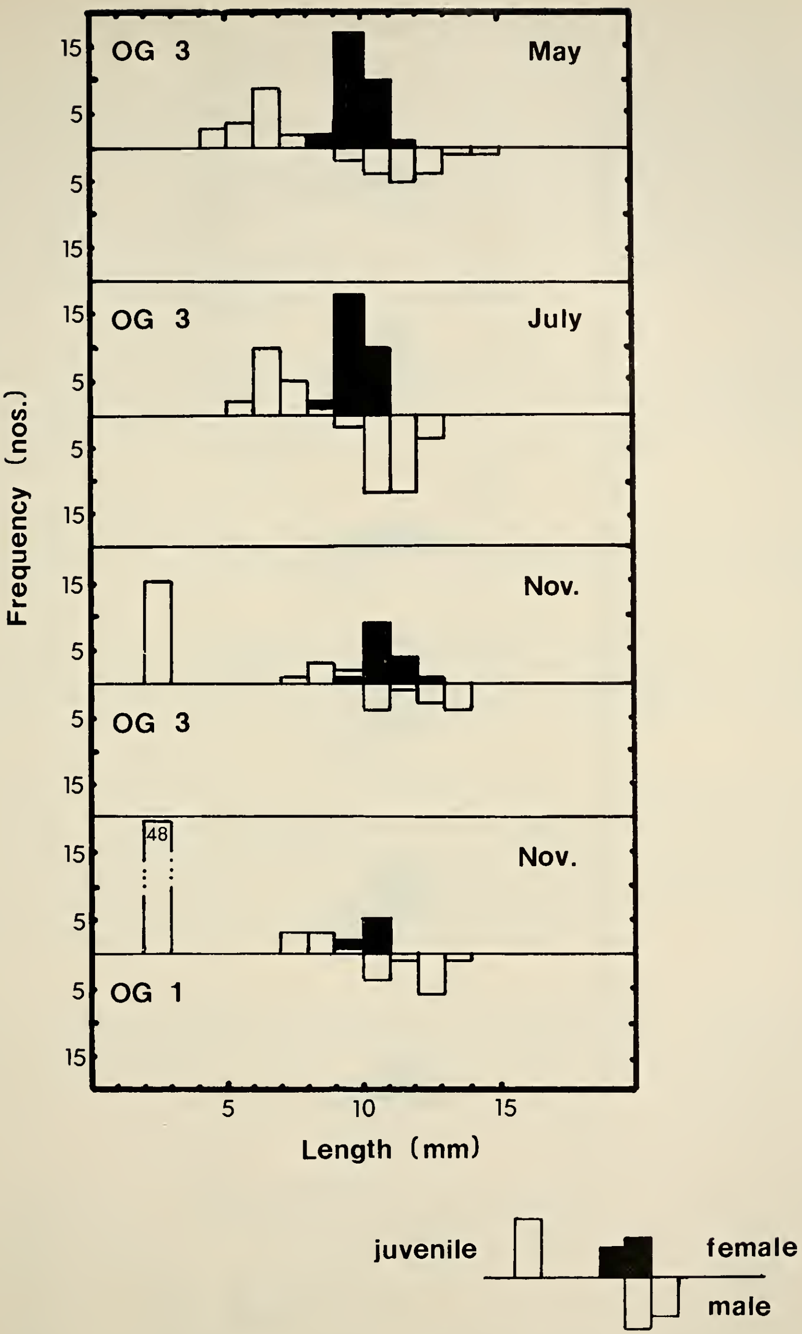

Fig. 7. Length (anterior margin of head to telson tip) frequency distribution of samples of *Onchotelson brevicaudatus* from Great Lake. Numbers within histogram indicate number in size class.

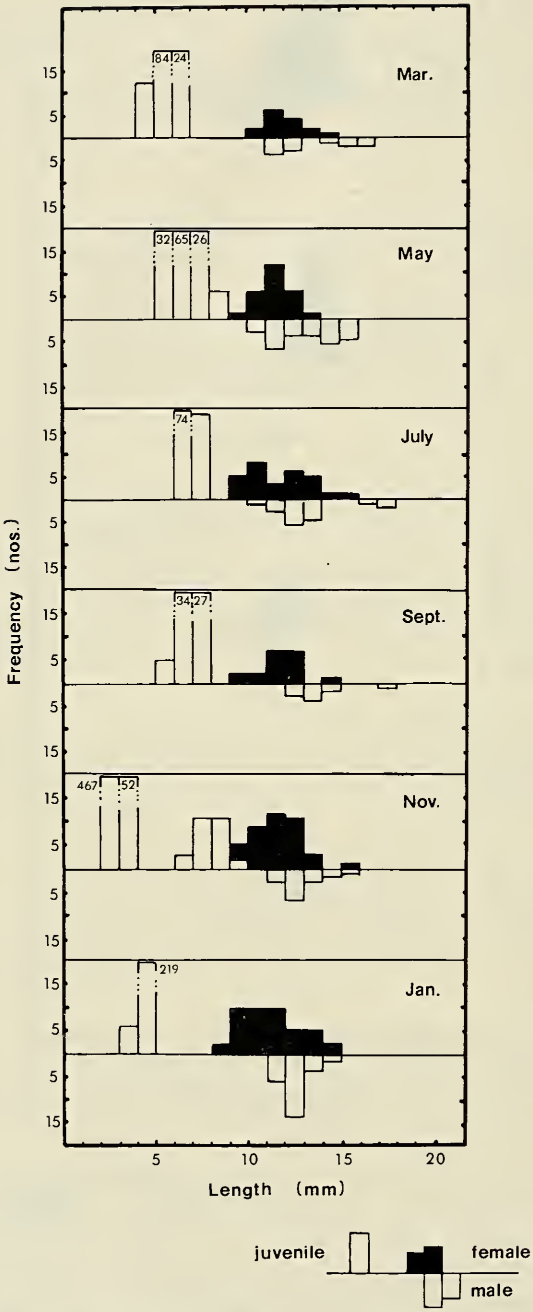

Fig. 8. Length-frequency distribution of samples of *Colubotelson* sp. from site OA2 in Arthurs Lake. Numbers within histogram indicate total number in size class.

Colubotelson sp. follows a similar reproduction pattern to *O. brevicaudatus.* Copulating pairs of this species were observed in the late July samples in Arthurs Lake whilst females with brood pouches were most common in the late September samples. Juveniles first appeared in late November samples at all sites. Data in Fig. 8 suggest that *Colubotelson* sp. does not survive long after reproducing. The one year age group has become sexually differentiated between November and January but the mean size of both females and males has decreased. This suggests that the larger adults from November were no longer present.

There was also some evidence to suggest that there was an inverse relationship between the size of *Colubotelson* sp. and population density at the various sites. At site NA2, in Arthurs Lake, where the overall population density of this species was highest, specimens were consistently smaller than the corresponding stage at the other sites.

Oligochaetes: Although they were abundant the life cycles of the oligochaete species were not studied. There was no obvious juvenile influx into the populations and fragmentation of most specimens made the investigation of size classes very difficult.

Juvenile *Haplotaxis ornamentus* were collected in small numbers during the latter half of the year but these numbers had no significant effect on the seasonal abundance (Fig. 5). Cocoons containing single eggs of this species were collected with the mid-year samples from both lakes.

Trichopterans: The life cycle of *Atriplectides dubius* was examined at one site only, (NG1). The length-frequency distributions of the cases of this species are given in Fig. 9 whilst the percentage of the samples in each instar are given in Table 3. The instar analysis, based on head capsule width, revealed four separate instars. It was assumed that there was one smaller instar which was not recorded as it was small enough to pass through the sieve used.

TABLE 3. Percentage frequency of each instar of *Atriplectides dubius* in samples from site NG 2. (Samples taken near end of month indicated).

	Instar				Total nos.
	2	3	4	5	
			%		
Jan.	30	37	23	10	43
Mar.	—	22	23	55	88
May	—	41	21	38	61
July	—	46	23	31	92
Sept.	2	19	40	39	93
Nov.	—	15	15	70	73

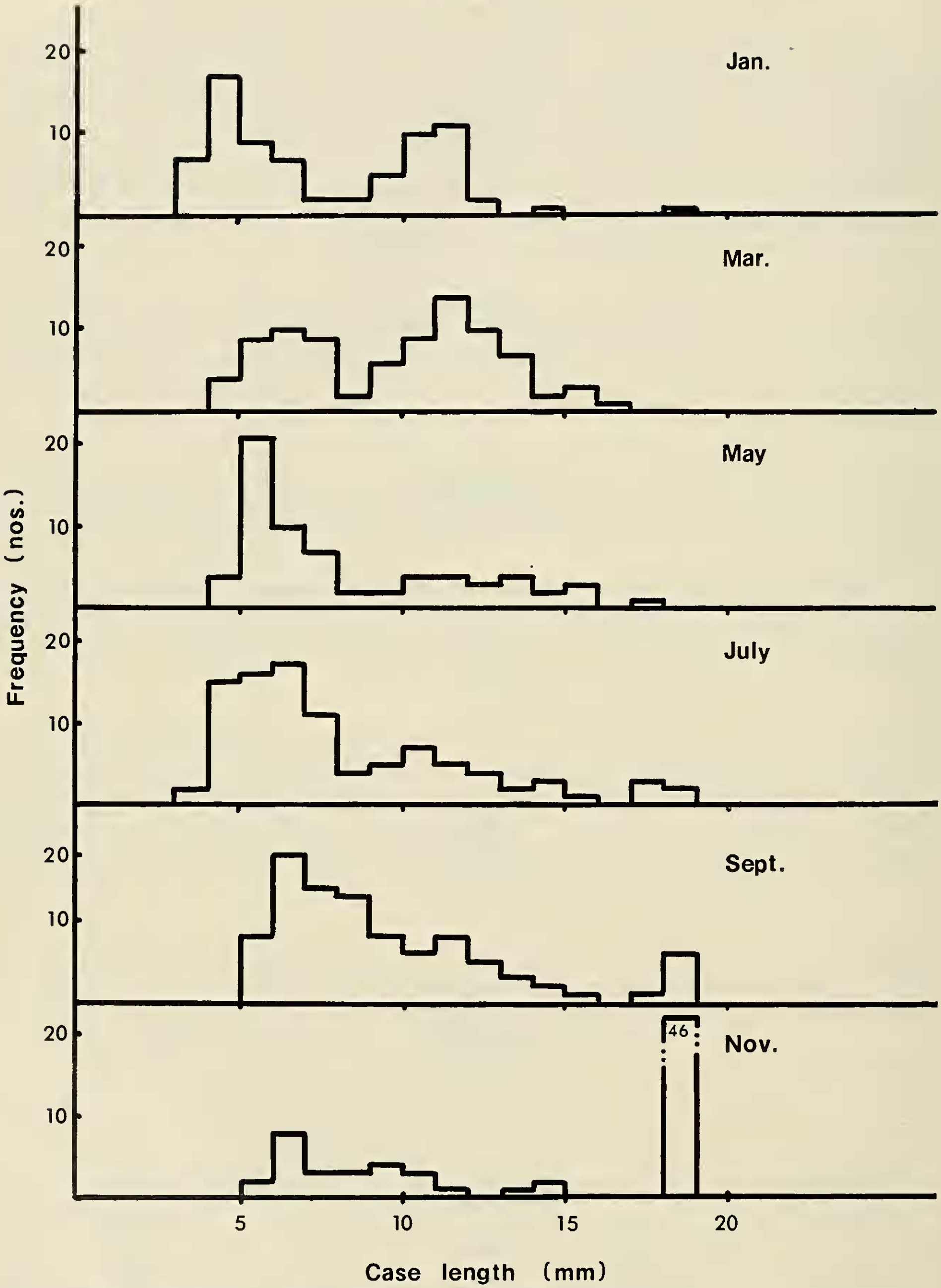

Fig. 9. Case-length/frequency distribution of samples of *Atriplectides dubius* at site NG2 in Great Lake. Numbers within histogram indicate total number in size class.

The pupae of *A. dubius* were about 18 mm total length. When pupating, the larvae detaches about 7-8 mm of the posterior part of its case and places this across the entrance to seal it. Therefore larvae above 18 mm in case length were all grouped together in Fig. 9. Pupating larvae were found predominantly in late November samples.

There are two possible explanations for the two peaks observed in the histograms (Fig. 9). It could indicate a two year life cycle and therefore two year classes are present. It is more likely that there are two generations per year with a major emergence in November-December and a further emergence between April and late May.

The analysis of instars (Table 3) suggests a December hatching with a juvenile influx in January. The high proportion of final instar larvae in March parallels the length data in Fig. 9, but the decrease in proportion of this group in the following sample as well as a decrease in abundance overall (Fig. 6) indicates that another emergence has taken place in autumn.

DISCUSSION

The results have shown that the seasonal variations in abundance of the various species studied can often be explained by examination of the life history of each species. The chironomids all have emergence periods somewhere in the spring-summer period and this emergence time is usually reflected in the abundance data. Some of the data suggest that emergence times and abundance peaks are a little earlier in Arthurs Lake than Great Lake.

Procladius villosimanus was briefly studied by Timms (1973) in Victoria. He found that there was probably only one generation per year with emergence taking place in summer and early autumn. The Arthurs Lake data for this species suggests a similar one year life cycle but a slightly earlier emergence time in Tasmania. Timms (1973) also studied *Coelopynia pruinosa* in Victoria. He cautiously suggested that this species had a one year life cycle with emergence mainly in summer. The inconsistency of abundance and instar data for this species at different sample sites in Great Lake and Arthurs Lake also suggests that conclusions should be made with caution although it appears likely that *C. pruinosa* has two generations per year in Great Lake and Arthurs Lake. Emergence trapping would be required to confirm this.

The other species studied all appear to have one generation per year with distinct emergence times. None of these species have been studied elsewhere. Data on life history of some congeneric species are given by Timms (1973) and Paterson and Walker (1974).

With the exception of the juvenile influx there is no consistent pattern in the seasonal abundance of the phreatoicids. In both *Onchotelson brevicaudatus* and *Colubotelson* sp. the seasonal patterns have different adult peak abundances which do not appear related to their life history. It is likely that these species show contagious distribution patterns (Fulton, 1981) and the observed abundance fluctuations therefore may not reflect the true situation.

The life history of *Colubotelson* sp. has been studied before (Engemann, 1963; Knott, 1971). Knott suggested a two year life cycle for this species in south-eastern Tasmania and this is supported by the Arthurs Lake data. The Great Lake species, *O. brevicaudatus,* has not previously been studied. It appears to have a similar life cycle to *Colubotelson* sp.

Observed peaks in abundance of oligochaetes at the various sites appeared unrelated to each other. Few studies have recorded consistent seasonal variations in this group. A four year study of the tubificid *Potamothrix hammoniensis* in Lake Esrom, Denmark (Jonasson and Thorauge, 1972) failed to find repeated abundance peaks. Whilst the study of Great Lake and Arthurs Lake was not as extensive, it is nevertheless difficult to explain the inconsistencies between sites in the same lake, particularly when the spatial distribution within a site of *H. ornamentus* for example, was found to be regular at some sites (Fulton, 1981).

Interpretation of the life cycle of *Atriplectides dubius* is tentative in the absence of comparative data for other lacustrine benthic trichopterans in Australia. However, there is good agreement between the abundance, length frequency and instar data which suggest that this species has two generations per year. This should be checked by light trapping.

The data presented on life history and seasonal variation in abundance of several species of benthic invertebrates from Great Lake and Arthurs Lake show little variation between the two lakes even though collections were made in different years. None of the suggested life cycles appear unusual for the groups concerned although little comparative data are available.

ACKNOWLEDGEMENTS

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REFERENCES

ENGEMANN, J. G. (1963). A comparison of the anatomy and natural history of *Colubotelson thomsoni* Nicholls, a south-temperate isopod and *Asellus communis* Say, a north-temperate freshwater isopod. Ph.D. Thesis, Michigan State University.

FULTON, W. (1981). The macrobenthic fauna of Great Lake and Arthurs Lake, Tasmania. M.Sc. Thesis, Uni. of Tas.

FULTON, W. (1983a). Macrobenthic fauna of Great Lake, Arthurs Lake and Lake Sorell, Tasmania. *Aust. J. Mar. Freshwater Res.* **34:** 775-85.

FULTON, W. (1983b). Qualitative and Quantitative variation in the macrobenthic fauna of the original lake and new lake area of Great Lake and Arthurs Lake, Tasmania. *Aust. J. Mar. Freshwater Res.* **34:** 787-803.

JONASSON, P. M. and THORAUGE, F. (1972). Life cycle of *Potamothrix hammoniensis* (Tubificidae) in the profundal of a eutrophic lake. *Oikos* **23:** 151-8.

KNOTT, B. (1971). Studies on some Tasmanian phreatoicids. B.Sc. Hons. Thesis, Uni. of Tas.

LAUFF, G. H., CUMMINS, K. W., ERIKSEN, H. and PARKER, M. (1961). A method for sorting bottom fauna samples by elutriation. *Limnol. Oceanog.* **6:** 462-6.

PATERSON, C. G. and WALKER, K. F. (1974). Seasonal dynamics and productivity of *Tanytarsus barbitarsis* Freeman (Diptera: Chironomidae) in the benthos of a shallow, saline lake. *Aust. J. Mar. Freshwat. Res.* **25:** 151-65.

TIMMS, B. V. (1973). A comparative study of the limnology of three maar lakes in western Victoria. Ph.D. Thesis, Monash University, Victoria.

TIMMS, B. V. (1978). The benthos of seven lakes in Tasmania. *Arch. Hydrobiol.* **81**(4): 422-44.

WEATHERLEY, A. H. and NICHOLLS, A. G. (1955). The effects of artificial enrichment of a lake. *Aust. J. Mar. Freshwat. Res.* **6:** 443-68.